Analysis of the spectrum of antimicrobial activity of the composite mixture of *Macadamia ternifolia* nut oil and *Opuntia ficus indica* L. cactus seeds and its application in medical practice

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Abstract. The paper considers the results of the analysis of the spectrum of antimicrobial activity of the composite mixture of *Macadamia ternifolia* nut oil and *Opuntia ficus indica L.* cactus seed oil. The study showed that combining these oils into a single composition provides a mechanism of complex antibacterial action tested on four typical test strains of bacterial cultures. Biologically active properties of the composite mixture of macadamia nut oil and prickly pear cactus seed oil are largely due to their fatty acid and antioxidant composition. In veterinary practice, this mixture can be used to treat dermatological diseases and improve the general condition of the integumentary tissues of farm animals during the rehabilitation of wound defects and traumatic injuries. One of the areas of application of the experimental mixture of *Macadamia ternifolia* nut oil and *Opuntia ficus indica L.* cactus seed oil is the prevention and treatment of traumatic tissue damage to the udder of lactating cows, caused by exposure to unfavorable factors during machine milking.

1 Introduction

The relevance of the study lies in the fact that the treatment and prevention of dermatological diseases and traumatic skin defects in farm animals require new environmentally friendly approaches and solutions.

This issue is especially acute in the context of treating traumatic injuries to the udder tissues of lactating cows obtained during machine milking [8].

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Traumatization of the udder and teat tissues of lactating cows is a fairly common problem on robotic farms, where machine milking is an integral part of the process of obtaining raw milk [7].

In recent years, veterinary medicine has increasingly turned its attention to treatment regimens for animals that involve minimal use of antibiotics. In this regard, drugs made from natural components, including compositions of biologically active oils, are becoming increasingly relevant.

The use of compositions of biologically active oils in the process of creating natural oil-based drugs is notable for its synergistic effect, which allows for a significant enhancement of the therapeutic properties of individual components [9]. A mixture of macadamia nut and prickly pear seed oils can be composed in various ratios, since a correctly selected dosage of each component not only increases the effectiveness of individual ingredients, but also improves their absorption by the body [8].

In recent years, various groups of authors have noted that the optimal ratio of these oils per 100 ml of the mixture can be defined as: 80 ml of macadamia nut oil and 20 ml of prickly pear seed oil [1, 4-5].

A composition composed in such a ratio combines various phytochemicals with unique properties and fairly high biological activity, which allows achieving the effect of a complex effect on the body [6].

The composite mixture is rich in a wide range of polyunsaturated fatty acids, vitamins and antioxidants, which determines its beneficial properties. The finished mixture should be placed in containers made of dark, thick glass with mandatory storage conditions at moderate temperatures and low light.

In the conditions of modern industry, macadamia nut oil is obtained using environmentally friendly technologies that allow preserving the maximum amount of biologically active substances.

The process of collecting and drying nuts is especially important. The collected nuts must be thoroughly cleaned of the green shell to prevent rotting and mold. Otherwise, the quality of the oil will be low, with an admixture of foreign odors and tastes caused by the vital activity of pathogenic microorganisms.

Macadamia nut oil, obtained by cold pressing with subsequent filtration, preserves the maximum number of useful substances and a delicate vanilla-coffee aroma, which is a sign of high-quality oil. The product, obtained in compliance with all technical standards, contains a number of biologically active fatty acids, a fairly wide range of vitamins (E, A, B1, B2, B5, B6, B12 and PP) and minerals (selenium, potassium, copper, zinc, magnesium, manganese and phosphorus) [2].

When obtaining oil from prickly pear cactus seeds, as in the case of macadamia oil, an important step is cleaning the seeds from the pulp. The reasons for the importance of this step are similar - preventing rotting and mold.

Oil from prickly pear cactus seeds obtained in compliance with technological processes, in addition to the high content of vitamins E and F, will be rich in beta-amyrin, phytosterols and polyunsaturated fatty acids, which together have not only an antioxidant, but also a mild anti-inflammatory and immunostimulating effect [7].

The combination of the above oils in a single composition provides a complex effect, allowing not only to nourish tissues, but also to provide an antimicrobial effect.

Due to the richness of the composition and the synergistic effect of the components, this composition can be adapted to the various needs of veterinary medicine, which makes the use of the mixture multifunctional.

Thus, the use of biologically active oils within a single formula allows you to create more effective and natural drugs that can solve a wide range of problems in the field of veterinary practice.

2 Materials and methods

The object of the study is a compositional mixture of oils from Macadamia ternifolia nut (80%) and *Opuntia ficus indica L.* cactus seeds (20%).

The experimental method was based on the standard sowing algorithm in accordance with a modification that involves replacing the disks with hollow cylinders with a volume of 0.2 ml and an internal diameter of 5 mm due to the characteristics of the samples being studied.

3 Results

An important point when choosing oil raw materials is the method of obtaining them, since the quality and biological activity of the product will ultimately depend on the production features.

When obtaining base oils, one of the gentlest methods is cold pressing. Natural oils obtained by cold pressing with subsequent filtration allow preserving the maximum number of useful substances.

Oil products obtained in compliance with all technical standards contain a number of biologically active fatty acids, a fairly wide range of vitamins and minerals.

This component composition helps relieve irritation, soothe inflamed skin, reduce redness and soften the texture of scar tissue.

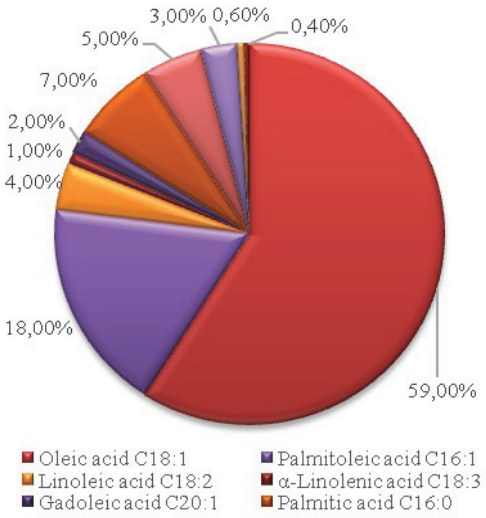


Fig. 1. Fatty acid composition of *Macadamia ternifolia* nut oil.

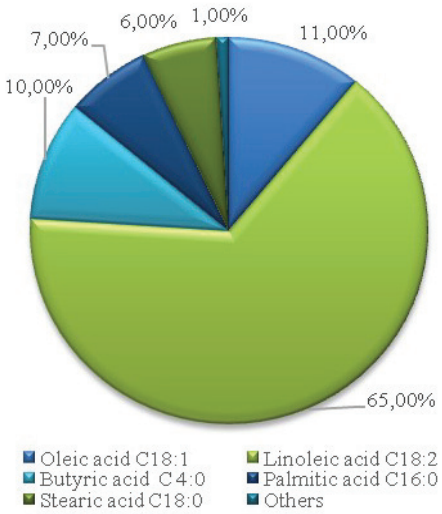


Fig. 2. Fatty acid composition of cactus seed oil *Opuntia ficus indica L.*

In order to study the antimicrobial activity and synergistic effect of the combination of biologically active oils, a composite mixture was prepared with the following proportions (per 100 ml):

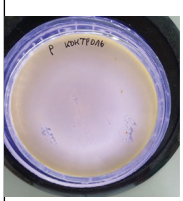
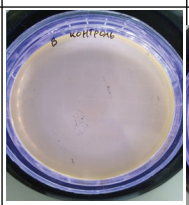
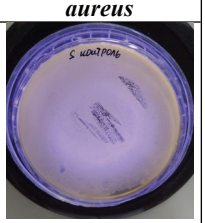
- Macadamia ternifolia nut oil - 80 ml.
- Opuntia ficus indica L. cactus seed oil - 20 ml.

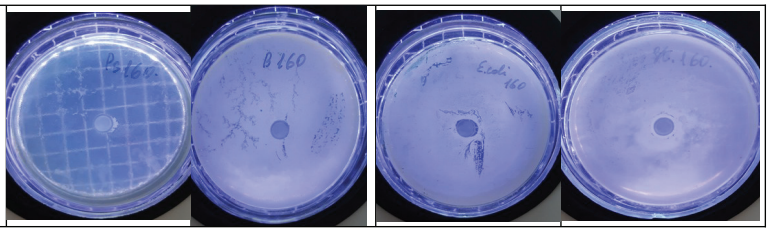
The composite mixture, composed in the above-described proportion, is rich in a wide range of polyunsaturated fatty acids, vitamins and antioxidants, which determines its beneficial properties. The combination of these oils into a single composition enables the mechanism of complex action to provide nutrition to damaged tissues, as well as provide an antimicrobial effect and wound healing effect.

The finished mixture should be placed in containers made of dark, dense glass with mandatory storage at a moderate temperature and low light to avoid loss of biological activity of the components.

The results of studies of the antimicrobial activity of the experimental mixture on nutrient media seeded with bacterial test strains are presented in Table 1.

Table 1. Antimicrobial activity of a composite mixture of *Macadamia ternifolia* nut oil and *Opuntia ficus indica L.* cactus seed oil.

Analysis Options	***Pseudomonas aeruginosa***	***Bacillus cereus***	***Escherichia coli***	***Staphylococcus aureus***
Pure test culture				
Diameter of bactericidal action, mm	5 mm	5 mm	6 mm	5 mm

Sample 160: Oil Blend (*Macadamia ternifolia, Opuntia ficus indica L.*)	

The analysis of Table 1 allows us to conclude that the composite mixture of oils obtained from *Macadamia ternifolia* nuts and *Opuntia ficus indica L.* cactus seeds has a local antibacterial effect, inhibiting the growth of test cultures directly under the cylinder (the diameter of the bactericidal effect is 5 mm). It should be noted that the oil mixture had a more active effect on the growth of E. coli. The diameter of the bactericidal effect that inhibits the growth of *Escherichia coli* is 6 mm.

Thus, we can conclude that due to the content of biologically active components, the mixture of oils obtained from macadamia nuts and prickly pear cactus seeds can have a wide range of applications.

The combination of these oils into a single composition provides a synergistic effect, enhancing their individual properties and creating a sought-after product.

In veterinary practice, this mixture can be used in the treatment of dermatological diseases and improving the general condition of the integumentary tissues of farm animals during the rehabilitation of wound defects and traumatic injuries.

One of the areas of application of the experimental mixture of *Macadamia ternifolia* nut oil and *Opuntia ficus indica L.* cactus seed oil is the prevention and treatment of traumatic tissue damage to the udder of lactating cows caused by machine milking.

4 Discussion

The features of the fatty acid composition of the seed oil of the cactus *Opuntia ficus indica* L. were covered in detail in the works of such authors as: Al-Naqeb G., Fiori L., Ciolli M., Aprea E. [1], Karabagias V.K., Karabagias I.K., Gatzias I., Badeka A.V. [4], Karabagias V.K., Karabagias I.K., Gatzias I., Riganakos K.A., Khaled S., Dahmoune F., Madani K., Urieta J., Mainar A. [5].

The features of the fatty acid composition of *Macadamia ternifolia* nut oil were covered in detail in the works of such authors as: Borisova A.V. [2], and the positive effect of biologically active micro- and macronutrients on a living organism is reflected in the works of Zhilich E. L. [9].

5 Conclusion

The conducted study showed that the composite mixture of *Macadamia ternifolia* nut oil and *Opuntia ficus indica L.* cactus seed oil has antimicrobial activity, which opens up broad prospects and makes this composition an interesting object for research in the field of veterinary medicine and phytotherapy.

The combination of these oils in a single composition works as a mechanism of complex action, which allows to provide nutrition to damaged tissues, as well as to have an antimicrobial effect and wound healing effect.

The results obtained on the basis of the study allow us to conclude that the biologically active properties of the composite mixture of macadamia nut oil and opuntia cactus seed oil are largely due to their fatty acid composition.

This component composition improves the barrier functions of the dermis and promotes tissue regeneration.

The biologically active base of Opuntia ficus indica L. cactus seed oil also consists of unsaturated fatty acids, among which a special place is occupied by linoleic acid (C:18:2, Omega-6), the content of which is 65%, and oleic acid (C18:1, Omega-9), the content of which is 11%, as well as saturated fatty acids, among which a special place is occupied by butyric acid (C4:0), the content of which is 10%, palmitic acid (C16:0), the content of which is 7%, and stearic acid (C18:0), the content of which is 6%.

This component composition helps to relieve irritation, soothe inflamed skin, reduce redness and soften the texture of scar tissue.

The composite mixture of oils obtained from *Macadamia ternifolia* nuts and *Opuntia ficus indica L.* cactus seeds have a local antibacterial effect, inhibiting the growth of test cultures directly under the cylinder (the diameter of the bactericidal effect is 5 mm).

It should be noted that the oil mixture had a more active effect on the growth of E. coli. The diameter of the bactericidal effect that inhibits the growth of Escherichia coli is 6 mm.

Thus, it can be concluded that due to the content of biologically active components, the mixture of oils obtained from macadamia nuts and prickly pear cactus seeds can have a wide range of applications.

The combination of these oils in a single composition provides a synergistic effect, enhancing their individual properties and creating a popular product.

In veterinary practice, this mixture can be used in the treatment of dermatological diseases and improving the general condition of the integumentary tissues of farm animals during the rehabilitation of wound defects and traumatic injuries.

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